PROPOSED

BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT) BACKGROUND DOCUMENT FOR PAINT PRODUCTION WASTES — K179 and K180

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DISCLAIMER STATEMENT

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EXECUTIVE SUMMARY

This background document provides the U.S. Environmental Protection Agency's (EPA's) rationale and technical support for developing Land Disposal Restriction (LDR) treatment standards for K179 and K180. EPA is proposing to list K179 and K180 as hazardous wastes:

- K179: Paint manufacturing waste solids generated by paint manufacturing facilities that, at the point of generation, contain any of the constituents identified in paragraph (b)(6)(iii) of this section at a concentration equal to or greater than the hazardous level set for that constituent in paragraph (b)(6)(iii) of this section. Paint manufacturing waste solids are: (1) waste solids generated from tank and equipment cleaning operations that use solvents, water and or caustic; (2) emission control dusts or sludges; (3) wastewater treatment sludges; and (4) off-specification product. Waste solids derived from the management of K180 by paint manufacturers would also be subject to this listing. Waste liquids derived from the management of K179 by paint manufacturers are not covered by this listing, but such liquids are subject to the K180 listing. For the purposes of this listing, paint manufacturers are defined as specified in paragraph (b) of this section.

  [The constituents and concentration levels for K179 wastes as identified in §261.32(b)(6)(iii) are proposed as follows:
  Acrylamide: 310 mg/kg
  Acrylonitrile: 43 mg/kg
  Antimony: 2,300 mg/kg
  Methyl isobutyl ketone: 73,000 mg/kg
  Methyl methacrylate: 28,000 mg/kg]

- K180: Paint manufacturing waste liquids generated by paint manufacturing facilities that, at the point of generation, contain any of the constituents identified in paragraph (b)(6)(iii) of this section at a concentration equal to or greater than the hazardous level set for that constituent in paragraph (b)(6)(iii) of this section unless the wastes are stored or treated exclusively in tanks or containers prior to discharge to a POTW or under a NPDES permit. Paint manufacturing liquids are generated from tank and equipment cleaning operations that use solvents, water, and/or caustic. Waste liquids derived from the management of K179 by paint manufacturers would also be subject to this listing. Waste solids derived from the management of K180 by paint manufacturers are not covered by this listing, but such solids are subject to the K179 listing. For the purposes of this listing, paint manufacturers are defined as specified in paragraph (b) of this section.

  [The constituents and concentration levels for K179 wastes as identified in §261.32(b)(6)(iii) are proposed as follows:
  Acrylamide: 12 mg/L
  Acrylonitrile: 9.3 mg/L

Antimony: 390 mg/L
Methylene chloride: 4,500 mg/L
Ethylbenzene: 11,000 mg/L
Formaldehyde: 82,000 mg/L
Methyl isobutyl ketone: 340 mg/L
Methyl methacrylate: 2,100 mg/L
n–Butyl alcohol: 41,000 mg/L
Styrene: 4,600 mg/L
Toluene: 1,200 mg/L
Xylene (mixed isomers): 3,900 mg/L]

EPA is prohibiting the land disposal of both nonwastewater and wastewater forms of Hazardous Waste Nos. K179 and K180 and proposing LDR treatment standards for these wastes. Specifically, EPA is proposing to apply numerical standards to 11 of the 12 hazardous constituents identified in the wastes (i.e., the exception is formaldehyde). EPA has determined that it is technically feasible to apply these existing numerical standards to the hazardous constituents of K179 and K180, because the applicable treatment technologies have been demonstrated for these constituents in other regulated wastes.

For formaldehyde, EPA is proposing technology specific standards. When formaldehyde is present in K180 at levels triggering the listing, the waste must be treated by the required technologies and then comply with any applicable numerical standards for other constituents. Wastes that do not trigger the listing based on formaldehyde are not subject to the formaldehyde technology requirement, but are subject to all other numerical standards.

EPA notes that because treatment standards are proposed for both metal and organic constituents, additional metal and organic constituents (beyond those that are specifically regulated) will also be immobilized or destroyed as a result of the treatment.

Characterization of Wastes

EPA conducted a survey of the U.S. paint manufacturing industry to collect information regarding paint production wastes, their management, and identify constituents potentially present in these wastes. EPA conducted this survey in early 2000. EPA identified potential constituents of concern using these survey results as well as from a literature search of raw materials used in paint and coatings.

EPA is proposing treatment standards for wastewater and nonwastewater forms of K179 and K180. The treatment standards are different for each category (nonwastewater or wastewater); EPA requires generators to identify whether their wastes is in a wastewater or nonwastewater form by examination of the total suspended solids and total organic carbon contents. K179 represents solid sludges and solid wastes associated with paint production. K179 wastes typically will be designated as nonwastewaters due to their significant solids content. K180 is liquid waste from paint production including solvents and washwaters. K180 solvent wastes typically will be designated as nonwastewaters due to their significant organic content; K180 aqueous wastes typically will be designated as wastewaters if they have sufficiently low organic and solids contents.

Development of BDAT Treatment Standards

For these wastes, EPA proposes to set treatment standards at the UTS level for the one metal in K179 and K180, and for 9 of the 11 organic constituents in K179 and K180 where UTS already exist. EPA believes it is technically feasible to apply these existing numerical standards to the hazardous constituents of K179 and K180, because the waste compositions are similar to other wastes for which applicable treatment technologies have been demonstrated. These UTS limits were initially published in the Land Disposal Restrictions Phase II final rulemaking (September 19, 1994; 59 FR 47980), with treatment standards for some of the metals updated in the LDR Phase IV rulemaking (May 28, 1998; 63 FR 28556).

For formaldehyde, EPA is transferring technology-specific treatment standards that currently exist for U122 wastes (discarded or off-specification formaldehyde product). For this constituent, our evaluation indicates that proposing a numerical treatment standard would not be appropriate due to a lack of treatment performance data.

For one organic constituent, styrene, numerical treatment standards have not previously been developed for any waste and EPA is proposing numerical standards developed for this rulemaking. EPA is proposing a wastewater standard of 0.028 mg/L based on activated sludge treatment and a nonwastewater standard of 28 mg/kg based on thermal destruction. Alternatively, EPA is proposing to transfer the treatment standards of ethyl benzene (0.057 mg/L for wastewaters and 10 mg/kg for nonwastewaters) due to its similarity to styrene in structure and physical properties.

Consistency with Other Provisions of LDR Program

EPA has previously developed UTS for most, but not all, of the constituents proposed for K179 and K180 numerical treatment standards. As a result of its calculation of a numerical treatment standard for styrene for these wastes, EPA is also proposing to add the numerical standard for styrene to the Universal Treatment Standards of 40 CFR 268.48. As a result, characteristic wastes subject to treatment requirements for underlying hazardous constituents will also have to comply with these new treatment standards.

EPA is also modifying treatment standards for another waste, F039 multisource leachate. F039 applies to landfill leachates generated from multiple listed hazardous waste in lieu of the original waste codes. F039 wastes are subject to numerical treatment standards applicable to all listed wastes. EPA is proposing to add two constituents to F039 treatment standards: acrylamide and styrene. Styrene previously had no treatment standards for any waste. Acrylamide, however, was listed on UTS but was not previously included on the list of F039 treatment standards.

Please see Table ES–1 for a full listing of the proposed treatment standards in K179 and K180, and the proposed additions to UTS and F039.

Alternative Risk Assessment Criteria

EPA identified a total of 12 constituents in K179 and K180 as a result of its risk assessment. These will be proposed for listing, and EPA will propose treatment standards for this same list of constituents. These constituents are proposed based on a risk assessment, by identifying probabilistic results at the 90th percentile. EPA has also identified probabilistic risk assessment results at the 95th percentile. One additional constituent, methanol, would be included in EPA's basis for listing if this more conservative risk assessment is used. To be consistent with the listing description, EPA has also identified possible treatment standards for methanol in Table ES–1.

Table ES–1 Summary of Proposed Treatment Standards for Hazardous Wastes K179 and K180

Regulated Hazardous Constituent	CAS[1] Number	Proposed Wastewater Treatment Standard, Concentration in mg/L [2], or Technology Code [3]	Proposed Nonwastewater Treatment Standard	Proposed Changes
Organic Constituents				
Acrylamide	79-06-1	19	23 mg/kg [4]	K179, K180, F039
Acrylonitrile	107-13-1	0.24	84 mg/kg [4]	K179, K180
n-Butyl alcohol	71-36-3	5.6	2.6 mg/kg [4]	K180
Ethyl benzene	100-41-4	0.057	10 mg/kg [4]	K180
Formaldehyde [5]	50-00-0	(WETOX or CHOXD) fb CARBN; or CMBST	CMBST	K180
Methanol[6]	67-56-1	5.6	0.75 mg/L TCLP	K180
Methylene chloride	75-09-2	0.089	30 mg/kg [4]	K180
Methyl isobutyl ketone	108-10-1	0.14	33 mg/kg [4]	K179, K180
Methyl methacrylate	80-62-6	0.14	160 mg/kg [4]	K179, K180
Styrene	100-42-5	0.028	28 mg/kg [4]	K180, F039, UTS
Toluene	108-88-3	0.080	10 mg/kg [4]	K180
Xylenes — mixed isomers (sum of o-, m-, and p-xylene concentrations)	1330-20-7	0.32	30 mg/kg [4]	K180
Metals				
Antimony	7440-36-0	1.9	1.15 mg/L TCLP	K179, K180

1. CAS means Chemical Abstract Services.
2. Concentration standards for wastewaters are expressed in mg/L and are based on analysis of composite samples.
3. All treatment standards expressed as a Technology Code or combination of Technology Codes are explained in detail in 40 CFR 268.42 Table 1-Technology Codes and Descriptions of Technology-Based Standards.
4. Except for Metals (EP or TCLP) and Cyanides (Total and Amenable) the nonwastewater treatment standards expressed as a concentration were established, in part, based upon incineration in units operated in accordance with the technical requirements of 40 CFR Part 264, Subpart O, or Part 265, Subpart O, or based upon combustion in fuel substitution units operating in accordance with applicable technical requirements. A facility may comply with these treatment standards according to provisions in 40 CFR 268.40(d). All concentration standards for nonwastewaters are based on analysis of grab samples.
5. Wastes that do not exceed the 40 CFR 261.32 listing criteria for this constituent are not subject to the treatment technology requirements, but are subject to all other numerical standards.
6. Public comment is being solicited for including methanol as a listing constituent in K180. Methanol would be included as a result of a more conservative risk assessment (i.e., using probabilistic risk assessment results at the more conservative 95th percentile). The other constituents in this table were identified based on examination of the probabilistic risk assessment results at the 90th percentile).

1.0 INTRODUCTION

RCRA Section 3004(m) specifies that treatment standards must minimize long- and short- term threats to human health and the environment arising from land disposal of hazardous wastes. EPA's general approach for complying with this requirement was promulgated as part of the November 7, 1986 Solvents and Dioxins rule. More recently, EPA has presented its guidance in establishing treatment standards in the Final Best Demonstrated Available Technology (BDAT) Background Document for Quality Assurance/Quality Control Procedures and Methodology, October 1991.

EPA's treatment standards for individual wastes are presented at 40 CFR 268.40. For a given waste, a treatment standard specifies (1) the concentration of each constituent in total or TCLP analysis, or (2) a technology which must be used for treating the waste. EPA establishes treatment standards for wastewaters and nonwastewaters, as well as any subgroups which may be appropriate. EPA has also established universal treatment standards (UTS) for underlying hazardous constituents; these are listed at 40 CFR 268.48.

EPA is proposing Land Disposal Restriction (LDR) treatment standards based on the Best Demonstrated Available Technology (BDAT) for the regulation of listed hazardous wastes proposed to be identified in 40 CFR 261.32 as K179 and K180. These BDAT treatment standards are being proposed in accordance with the amendments to the Resource Conservation and Recovery Act (RCRA) of 1976 enacted by the Hazardous and Solid Waste Amendments (HSWA) of November 8, 1984. HSWA amended RCRA to require EPA to promulgate treatment standards for a waste within 6 months after determining it is hazardous [Section 3004(g)(4)].

Compliance with the proposed treatment standards is a prerequisite for land disposal, as defined in 40 CFR Part 268. In 40 CFR 268.44, EPA supplies provisions that, if met, may justify granting a variance from the applicable treatment standards. In 40 CFR 268.6, EPA supplies provisions that, if met, may justify granting waste- and site-specific waivers from the applicable treatment standards in 268.40.

The proposed hazardous wastes K179 and K180 are generated during the manufacture of paints. These hazardous wastes are proposed to be defined as follows:

- K179: Paint manufacturing waste solids generated by paint manufacturing facilities that, at the point of generation, contain any of the constituents identified in paragraph (b)(6)(iii) of this section at a concentration equal to or greater than the hazardous level set for that constituent in paragraph (b)(6)(iii) of this section. Paint manufacturing waste solids are: (1) waste solids generated from tank and equipment cleaning operations that use solvents, water and or caustic; (2) emission control dusts or sludges; (3) wastewater treatment sludges; and (4) off-specification product. Waste solids derived from the management of K180 by paint manufacturers would also be subject to this listing. Waste liquids derived from the management of K179 by paint manufacturers are not covered by this listing, but such liquids are subject to the K180 listing. For the purposes of this listing, paint manufacturers are defined as specified in paragraph (b) of this section.

  [The constituents and concentration levels for K179 wastes as identified in §261.32(b)(6)(iii) are proposed as follows:
  Acrylamide: 310 mg/kg
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  Antimony: 2,300 mg/kg
  Methyl isobutyl ketone: 73,000 mg/kg
  Methyl methacrylate: 28,000 mg/kg]

- K180: Paint manufacturing waste liquids generated by paint manufacturing facilities that, at the point of generation, contain any of the constituents identified in paragraph (b)(6)(iii) of this section at a concentration equal to or greater than the hazardous level set for that constituent in paragraph (b)(6)(iii) of this section unless the wastes are stored or treated exclusively in tanks or containers prior to discharge to a POTW or under a NPDES permit. Paint manufacturing liquids are generated from tank and equipment cleaning operations that use solvents, water, and/or caustic. Waste liquids derived from the management of K179 by paint manufacturers would also be subject to this listing. Waste solids derived from the management of K180 by paint manufacturers are not covered by this listing, but such solids are subject to the K179 listing. For the purposes of this listing, paint manufacturers are defined as specified in paragraph (b) of this section.

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  Acrylamide: 12 mg/L
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  Antimony: 390 mg/L
  Methylene chloride: 4,500 mg/L
  Ethylbenzene: 11,000 mg/L

Formaldehyde: 82,000 mg/L
Methyl isobutyl ketone: 340 mg/L
Methyl methacrylate: 2,100 mg/L
n–Butyl alcohol: 41,000 mg/L
Styrene: 4,600 mg/L
Toluene: 1,200 mg/L
Xylene (mixed isomers): 3,900 mg/L]

This background document provides EPA's rationale and technical support for developing LDR treatment standards for proposed hazardous wastes K179 and K180.

1.1 Regulatory Background of Hazardous Wastes from Inorganic Chemicals Industry

Section 3001(e)(2) of RCRA requires EPA to determine whether to list as hazardous 'paint production wastes' (among other wastes unrelated to the paint manufacturing industry). In 1989, the Environmental Defense Fund (EDF) sued EPA (EDF v. Reilly, Civ. No. 89-0598 D.D.C.) in part for failing to meet these statutory deadlines. EPA and EDF entered into a consent decree, which has been amended several times to revise dates. The consent decree sets out a series of deadlines for promulgating RCRA listing decisions, including a requirement to propose a hazardous waste listing determination for paint production wastes. The wastes specified in the consent decree relevant to paint production are as follows:

- solvent cleaning wastes
- water/caustic cleaning wastes
- wastewater treatment sludge
- emission control dust or sludge
- off-specification production wastes.

EPA's investigation of the wastes generated by the paint production industry included two major information collection efforts: field investigations and survey evaluation. EPA's field investigations included engineering site visits.[1] The survey effort included (1) the identification of facilities potentially generating the wastes, and (2) the development, distribution, and assessment of an

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[1] EPA often conducts sampling when making a listing determination. In this case, no sampling of paint production wastes was conducted.

extensive industry-wide RCRA Section 3007 survey. These activities were conducted in late 1999 and in 2000.

1.2 Approach Used for BDAT Standard Development

The LDR program is designed to protect human health and the environment by prohibiting the land disposal of RCRA hazardous wastes unless specific treatment standards are met. In RCRA Section 3004(m), Congress directed EPA to: ". . . promulgate . . . levels or methods of treatment . . . which substantially diminish the toxicity of the waste or . . . the likelihood of migration of hazardous constituents . . . so that short-term and long-term threats to human health and the environment are minimized." Key provisions of the LDR program require that: (1) treatment standards are met prior to land disposal, (2) treatment is not evaded by long-term storage, (3) actual treatment occurs rather than dilution, (4) record keeping and tracking follow a waste from "cradle to grave" (i.e., generation to disposal), and (5) certification verifies that the specified treatment standards have been met.

In developing the proposed LDR treatment standards for these wastes, EPA first identified the constituents that comprise the basis of the proposed listings. EPA is proposing treatment standards for each of these constituents. EPA previously investigated performance data for many of these constituents through its development of universal treatment standards (UTS) at 40 CFR 268.48. EPA then identified the Best Demonstrated Available Technology (BDAT) for the hazardous constituents present in the wastes proposed for listing. For constituents lacking universal treatment standards, EPA used available data to calculate treatment standards, when appropriate, for this proposed rule.

A universal treatment standard is a single concentration limit established for a specific constituent regardless of the waste matrix in which it is present (i.e., the same treatment standard applies to a particular constituent in each waste code in which it is regulated). Universal treatment standards represent a significant improvement in the LDR program. In the past, different listed hazardous wastes may have had different concentration standards for the same constituent, which raised significant compliance problems when wastes with different standards for the same chemical were comanaged. With the universal treatment standards, the variability in constituent concentrations across listed hazardous waste treatment standards was eliminated. Currently, when a mixture of listed hazardous wastes is treated, the constituents must be treated to the same constituent concentration standard regardless of the waste codes assigned to the mixture.

EPA established two different sets of universal treatment standards: one for nonwastewater forms of waste and one for wastewater forms of waste. These two sets differ in the population of regulated constituents and the individual universal treatment standards. EPA initially developed universal treatment standards in 1994 for many inorganic and organic contaminants. Treatment standards for some of these metal contaminants were subsequently revised (based on additional data) as part of the Phase IV final rule (63 FR 28556, May 26, 1998).

1.3 Additional LDR Provisions Proposed in This Rule

EPA has previously developed UTS for most, but not all, of the constituents proposed to as the basis for listing K179 and K180. As a result, EPA is calculating treatment standards for the remaining constituent that will be applicable to these two wastes. EPA is also proposing to add the numerical standard for styrene to the Universal Treatment Standards of 40 CFR 268.48. As a result, characteristic wastes subject to treatment requirements for underlying hazardous constituents will also have to comply with these new treatment standards.

EPA is also modifying treatment standards for another waste, F039 multisource leachate. F039 applies to landfill leachates generated from multiple listed hazardous waste in lieu of the original waste codes. F039 wastes are subject to numerical treatment standards applicable to all listed wastes. EPA is proposing to add two constituents to F039 treatment standards: acrylamide, and styrene. Styrene previously had no treatment standards for any waste. Acrylamide, however, was listed on UTS and for consistency is being proposed for addition to the list of F039 treatment standards.

1.4 Contents of This Document

Section 2.0 of this document describes the industry and processes generating proposed Hazardous Waste Nos. K179 and K180, the proposed basis for listing these paint production wastes as hazardous, waste stream characteristics, and the constituents selected for treatment standard development for these wastes. Section 3.0 discusses development of the treatment standards for the proposed wastes. This section discusses the treatment technologies EPA has designated as "applicable" and "demonstrated" for the waste, identifies BDAT for wastewater and nonwastewater forms of these wastes, and presents the proposed treatment standards. References are listed in Section 4.0. Appendix A presents the calculations and data used for the treatment standard calculation for styrene, and available treatment and analytical data for formaldehyde.

2.0 DESCRIPTION OF PAINT PRODUCTION WASTES PROPOSED FOR LISTING

2.1 Industry Overview

Paints and coatings are formulated to protect and decorate surfaces as well as enhance desired surface properties such as electrical conductivity and corrosion protection. EPA estimates that there are approximately 1000 paint and coatings manufacturing facilities operating in the United States. Products from this industry are categorized into three main groups according to end use: (1) architectural coatings, (2) original equipment manufacturing (OEM) product finishes, and (3) special purpose coatings. Paint and coatings may be either solvent or water-based according to desired end-use specifications.

Architectural coatings, also referred to as trade sales paints, include exterior and interior house paints, stains, varnishes, undercoats, primers, and sealers. OEM product finishes are custom formulated for application to products during the manufacturing process; examples of such products include automobiles, appliances, machinery and equipment, toys and sporting goods, wood furniture and fixtures, coil coatings, electrical insulation, factory-finished wood, metal containers, paper, film and foil, and non-automotive transportation. Special purpose paints are formulated for specific applications or extreme environmental conditions (e.g., chemical resistance or temperature extremes) and include: high-performance maintenance coatings (used in refineries, public utilities, bridges, etc.); automotive refinishing; highway traffic markings; aerosol paints; and marine coatings.

Typical components of paint and coatings include:

- Pigments — Insoluble particulates used to give the paint film color as well as structured strength, as well as in some cases imparting corrosion resistance or other properties to paint film.
- Solvents — Solvents used both in traditional “oil” based (solvent based) paints, as well as those solvents used in waterborne paints.
- Binders — Organic polymeric compounds used to adhere the pigment particles and other paint ingredients into a film on the surface being painted.

- Additives — Inorganic and organic metal-containing raw material additives such as driers (siccatives), catalysts, stabilizers.

- Biocides — Compounds used to kill microorganisms and larger organisms such as insects. Categories of biocides include insecticides, anti-fouling compounds (for use on ships), fungicides, algaicides, and mildewcides.

2.2 Processes Used and Wastes Generated

Paint and coatings are typically produced in batches. They are made in stationary and portable equipment such as high-speed dispersion mixers, rotary batch mixers and blenders, sand mills, and tanks. Raw materials include solvents, resins (or "binders"), pigments, and additives comprised of inorganic and organic chemicals. Generally, paint manufacturing does not involve chemical reactions between the raw materials, so the finished paint consists of a mixture of the different raw materials.

Wastes generated include the following five wastes specifically identified in the consent decree:

- solvent cleaning wastes
- water/caustic cleaning wastes
- wastewater treatment sludge
- emission control dust or sludge
- off-specification production wastes.

Solvent and Water/Caustic Cleaning Wastes: The process equipment is cleaned regularly to mitigate product contamination as well as to restore operational efficiency. The equipment is also cleaned during manufacturing shut downs and when a significant change in production line occurs. Depending on the type of paint manufactured, process equipment may be cleaned with either solvent, water, or aqueous caustic washes.

Wastewater Treatment Sludge: Paint manufacturing facilities may use onsite treatment for its generated wastewaters. In addition to the cleaning wastes identified above, other sources of wastewater include floor washdown and spill cleanup. A typical treatment for wastewaters is physical-chemical. This usually involves chemical addition and gravity settling of suspended solids which generates a cleaner effluent, and a sludge.

Emission Control Wastes: Airborne material is generated when dry materials, such as pigments, are loaded into processing equipment. Air hoods and exhaust fans help control the level of airborne particulate material released into the paint production areas. Material is collected in emission control systems such as bag houses. Pigments comprise a large fraction of the dry materials collected in emission control systems. Other raw materials that may be collected in emission control systems include additives (such as fillers) and solvents.

Off-Spec Product: A paint is considered off-specification if it cannot be sold "as is." For instance, if a paint is manufactured and customer demand changes, new superior products are created, or the product's shelf life expires, then the paint may be considered off-specification. In addition, off-specification product can result from operator error, equipment malfunction, improper equipment cleaning, or quality control failure during the manufacturing process. It may also include small quantities of retained product samples.

2.3 Constituents Typically Present in Wastes

EPA has no data characterizing paint production wastes. Instead, EPA relied on various sources to identifying the constituents of particular concern that may be used in paint formulation, and therefore present in the wastes. EPA initially used data sources such as textbooks, monographs, articles and material safety data sheets addressing paint and coatings, as well as data from the Toxics Release Inventory. EPA further identified constituents that were potentially present in wastes from the results of its waste management survey distributed in early 2000.

EPA used the results of this analysis, in conjunction with its risk assessment, to identify constituents of concern in paint production wastes. These formed the basis for the concentration-based listing described in Section 1 of this report.

3.0 TREATMENT STANDARD DEVELOPMENT FOR K179 AND K180

EPA is required to set as treatment standards "... levels or methods of treatment, if any, which substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents from the waste so that short-term and long-term threats to human health and the environment are minimized." [RCRA Section 3004(m)(1)].

To meet the requirements of the statute, EPA can propose either technology-specific or numerical treatment standards. This section develops the proposed treatment standards for these constituents in wastewater and nonwastewater forms of K179 and K180 to best meet the requirements of RCRA Section 3004(m). The section is organized in the following manner:

- Section 3.1 provides an overview of the treatment needs of the waste.
- Section 3.2 discusses wastewater forms of K179 and K180. Specifically, technologies applicable for treating the organic and metal constituents identified in the waste are discussed in Sections 3.2.1 and 3.2.2, respectively. The technology or technologies identified as BDAT, and the proposed treatment standards, are then presented in Section 3.2.3. EPA's conclusion is presented in Section 3.2.4.
- Section 3.3 discusses nonwastewater forms of K179 and K180. The format of the discussion is similar to that for wastewater forms of K179 and K180.

3.1 Summary of Constituents Selected for Regulation

Table 3–1 identifies constituents for which treatment standards are being proposed for K179 and K180. These constituents are identical to those being proposed as a basis for listing.

The constituents in Table 3–1 include organic and inorganic constituents. Section 3.1 discusses treatment technologies applicable to these constituents in wastewater forms of wastes. Section 3.2 discusses treatment technologies applicable to these constituents in nonwastewater forms of wastes. EPA anticipates that K179 will be predominantly generated in a nonwastewater form (e.g., sludges and solids). EPA anticipates that K180 waste will be generated in both wastewater and nonwastewater forms (e.g., caustics, washwaters, spent organic solvents).

Table 3–1 Constituents and Proposed Treatment Codes by Hazardous Waste Code

Regulated Hazardous Constituent	**CAS Number**	**Proposed Wastewater Treatment Standard, Concentration in mg/L, or Technology Code**	**Proposed Nonwastewater Treatment Standard**
Constituents for Listing K179 and K180			
Acrylamide	79-06-1	19	23 mg/kg
Acrylonitrile	107-13-1	0.24	84 mg/kg
Antimony	7440-36-0	1.9	1.15 mg/L TCLP
Methyl isobutyl ketone	108-10-1	0.14	33 mg/kg
Methyl methacrylate	80-62-6	0.14	160 mg/kg
Constituents for Listing K180 only			
n-Butyl alcohol	71-36-3	5.6	2.6 mg/kg
Ethyl benzene	100-41-4	0.057	10 mg/kg
Formaldehyde	50-00-0	(WETOX or CHOXD) fb CARBN; or CMBST	CMBST
Methanol[A]	67-56-1	5.6	0.75 mg/L TCLP
Methylene chloride	75-09-2	0.089	30 mg/kg
Styrene	100-42-5	0.028	28 mg/kg
Toluene	108-88-3	0.080	10 mg/kg
Xylenes — mixed isomers (sum of o-, m-, and p-xylene concentrations)	1330-20-7	0.32	30 mg/kg

A. Public comment is being solicited for including methanol as a listing constituent in K180. The treatment standard would correspond to the existing standard for methanol in wastes subject to UTS. Methanol, an organic, could be treated using the technologies described in Sections 3.2.1 (for wastewaters) and 3.3.1 (for nonwastewaters).

3.2 Wastewater Forms of K179 and K180

K179 is a liquid waste when generated. Depending on its percent solids content and its organic carbon content it may be classified as either a wastewater or a nonwastewater (40 CFR 268.2). The technologies listed here are expected to be applicable to wastewater forms of K179. Some of the technologies listed here are also expected to be applicable to nonwastewater forms of K179, as long as it has characteristics of a pumpable aqueous waste.

Although K180 is typically generated as a solid or sludge, the technologies described here would be applicable to wastewater forms of K180 if generated, for example, as a result of treatment.

3.2.1 Applicable and Demonstrated Technologies for Treating Organic Constituents

To be applicable, a technology must theoretically be usable to treat the waste in question or a waste that is similar, in terms of parameters that affect treatment selection (EPA, 1994b). EPA (1994b) presents a thorough discussion of the following technologies which are applicable and have been demonstrated to treat organic constituents in wastewater forms of other hazardous wastes:

- Biological treatment (including aerobic fixed film, aerobic lagoon, activated sludge, anaerobic fixed film, rotating biological contactor, sequential batch reactor, and trickling filter technologies)
- Carbon adsorption treatment (including activated carbon and granular activated carbon technologies)
- Chemically assisted clarification treatment (including chemical precipitation technology)
- Chemical oxidation
- PACT® treatment (including powdered activated carbon addition to activated sludge and biological granular activated carbon technologies)
- Reverse osmosis treatment
- Solvent extraction treatment (including liquid/liquid extraction)
- Stripping treatment (including steam stripping and air stripping technologies)
- Wet air oxidation treatment (including supercritical oxidation technology)

- Incineration
- Total recycle or reuse.

The concentrations and type(s) of constituent present in the waste generally determine which technology is most applicable. For example, some technologies are appropriate for treating wastes with relatively high concentrations of organic constituents (up to 1 percent), while others are more appropriate for lower concentrations. Such limitations are identified in the discussions below.

Biological Treatment

Biological treatment is a destruction technology that biodegrades hazardous organic constituents in wastewaters. This technology is also applicable to wastewaters that contain metals in low concentrations, where the contaminant becomes bound in the biosludge. This technology generates two treatment residuals: a treated effluent and a waste biosludge. Biological treatment is generally applicable for treatment of wastewaters containing up to one percent total organic constituents.

Carbon Adsorption

Carbon adsorption is a separation technology that selectively adsorbs organic constituents in wastewaters onto activated carbon. This technology generates two treatment residuals: a treated effluent and spent activated carbon. The spent activated carbon may be reactivated, recycled, incinerated, or land disposed (in accordance with land disposal restrictions).

Carbon adsorption is often used as a polishing step following primary treatment by biological treatment, solvent extraction, or wet air oxidation. Typically, carbon adsorption is applicable for treatment of wastewaters containing less than 0.1% total organic constituents.

Chemically Assisted Clarification Treatment

Chemically assisted clarification, including chemical precipitation, is a separation technology that removes organic and inorganic constituents from wastewater by the addition of chemicals that cause the formation of precipitates. The solids formed are then separated from the wastewater by settling, clarification, and/or polishing filtration. This technology generates two treatment residuals: treated wastewater effluent and separated solid precipitate.

Chemical Oxidation

Chemical oxidation is a destruction technology that oxidizes inorganic cyanide, some dissolved organic compounds, and sulfides to yield carbon dioxide, water, salts, simple organic acids, and sulfates. This technology generates one treatment residual: treated effluent.

PACT® Treatment

PACT® treatment combines carbon adsorption and biological treatment to biodegrade hazardous organic constituents and selectively adsorb them onto powdered activated carbon. This technology generates two treatment residuals: a treated effluent and spent carbon/biosludge. The spent carbon is often regenerated and recycled to the process or incinerated. Metal constituents may also adsorb on the carbon/biosludge. PACT® treatment is generally applicable for treatment of wastewaters containing up to one percent total organic constituents.

Reverse Osmosis

Reverse osmosis is a separation technology that removes dissolved organics (usually salts) from a wastewater by filtering the wastewater through a semipermeable membrane at a pressure greater than the osmotic pressure caused by the dissolved organics in the wastewater. This technology generates two treatment residuals: the treated effluent and the concentrated organic salt materials which do not pass through the membrane.

Solvent Extraction

Solvent extraction is a separation technology that removes organic compounds from a waste due to greater constituent solubility in a solvent phase than in the waste phase. This technology generates two residuals: a treated waste residual and an extract. Solvent extraction is generally applicable for treatment of wastewaters containing up to one percent total organic constituents.

Stripping Treatment

Stripping treatment is a separation technology in which volatile organic constituents in a liquid waste are physically transferred to a flowing gas or vapor. In steam stripping, steam contacts the waste, strips the volatile organics, and carries them to a condenser where the mixture of organic vapors and steam is condensed and collected in an accumulator tank. In air stripping, air contacts the waste and strips the volatile organic constituents. Stripping generates two treatment residuals: treated effluent and condensed vapors.

Wet Air Oxidation

Wet air oxidation is a destruction technology that oxidizes hazardous organic constituents in wastes under pressure at elevated temperatures in the presence of dissolved oxygen. This technology is applicable for wastes comprised primarily of water and with up to 10 percent total organic constituents. Wet air oxidation generates one treatment residual: treated effluent. The treated effluent may require further treatment for hazardous organic constituents by carbon adsorption or PACT® treatment. Trapped air emissions from wet air oxidation may also require further treatment.

Incineration

Please see Section 3.3.1 for a discussion of incineration.

Total Recycle or Reuse

Total recycle or reuse within the same process or an external process eliminates waste generation. As a result of recycling, however, impurities may require removal from the system on a periodic or continuous basis.

3.2.2 Applicable and Demonstrated Technologies for Treating Metals

To be applicable, a technology must theoretically be usable to treat the waste in question or a waste that is similar, in terms of parameters that affect treatment selection (EPA, 1994b). Applicable technologies for treating metals are those that remove, or transfer, metals from the wastewater to a nonwastewater media, such as a sludge. The technologies listed in this section are applicable and have been demonstrated to treat metal constituents in wastewater forms of other hazardous wastes. EPA (1994b) presents a thorough discussion of these technologies. The technologies applicable to wastewater forms of K179 and K180 include:

- Biological treatment (including activated sludge, aerobic lagoon, rotating biological contactor, and trickling filter technologies)
- Chemically assisted clarification treatment (including chemical precipitation technology)
- Chemical oxidation
- PACT® treatment
- Chemical reduction treatment (including chemical reduction or precipitation followed by sedimentation and filtration technologies)
- Electrochemical treatment
- Lime, sedimentation, and filtration treatment.

Biological treatment, chemically assisted clarification treatment, chemical oxidation, and PACT® treatment are discussed in Section 3.2.1. Brief descriptions of the other treatment technologies applicable for metals treatment are presented below.

Chemical Reduction Treatment

Chemical reduction treatment reduces metal constituents from a higher oxidation state to a lower oxidation state, and subsequently removes the contaminants from the wastewater using chemical precipitation and subsequent sedimentation and/or filtration. This technology generates two treatment residuals: a treated effluent and a settled or filtered solid containing the precipitated metal.

Electrochemical Treatment

Electrochemical treatment is a technology in which direct current is applied to iron electrodes submerged in the wastewater, generating ferrous ions. Metal constituents are removed by adsorbing and coprecipitating within insoluble ferrous ion matrices. These matrices settle out of solution using chemically assisted clarification (described above). This technology produces two treatment residuals: a treated effluent and a settled solid containing the precipitated metal.

Lime, Sedimentation and Filtration Treatment

As a separation technology, this treatment mixes wastewaters with lime (primarily calcium oxide) which produces an insoluble metal oxide which settles out of solution. The wastewater is filtered to remove the precipitated material. This treatment technology produces two residuals: a treated effluent and a filter cake containing lime and metals oxides.

3.2.3 Identification of BDAT and Proposed Treatment Standards for Wastewater Forms of K179 and K180

EPA determines BDAT for individual constituents, and wastes, upon review of all available performance data on treatment of the waste of concern or of similar wastes (EPA, 1994a). Once the applicable and demonstrated treatment technologies are identified for the particular waste, performance data are examined to identify the "best" performing technologies. This criteria includes:

- Whether the data represent the operation of a well-designed and well-operated treatment system;

- Whether sufficient analytical quality assurance/quality control measures were used to ensure the accuracy of the data; and

- Whether the appropriate measure of performance was used to assess the performance of the particular treatment technology.

Once this is determined, EPA decides where the best demonstrated technology is "available." EPA defines an available technology as one that:

- Is not a proprietary or patented process and can be purchased or licensed from the proprietor, and

- Substantially diminishes the waste's toxicity or substantially reduces the likelihood that hazardous contaminants will migrate from the waste (EPA, 1994a).

Table 3–2 summarizes BDAT for metals and organics that are constituents of K179 and/or K180. The technologies presented in Table 3–2 for the constituents in wastewater forms of K179 and K180 were used to calculate UTS limits published in the Land Disposal Restrictions Phase II final rulemaking (September 19, 1994; 59 FR 47980), the LDR Phase IV rulemaking (May 28, 1998; 63

FR 28556), and their associated background documents. These technologies can be used to meet the universal treatment standards being proposed today.

Table 3–2 Treatment Technologies Selected as BDAT for Constituents in K179 and K180

Regulated Hazardous Constituent	Technology Identified as BDAT
Organic Constituents for Listing K179 and K180	
Acrylamide	wet air oxidation
Acrylonitrile	biological treatment
Methyl isobutyl ketone	biological treatment
Methyl methacrylate	biological treatment
Organic Constituents for Listing K180 Only	
n-Butyl alcohol	biological treatment
Ethyl benzene	biological treatment
Formaldehyde [A]	WETOX or CHOXD fb CARBN; or CMBST
Methylene chloride	steam stripping
Styrene	activated sludge
Toluene	steam stripping
Xylenes — mixed isomers (sum of o-, m-, and p-xylene concentrations)	wet air oxidation
Metals for Listing K179 and K180	
Antimony	lime addition fb sedimentation fb filtration

Note: Treatment technologies are not summarized in this section for methanol. Public comment is being solicited on whether to include methanol as a listing constituent in K180; the treatment standard would correspond to the existing standard for methanol in wastes subject to UTS. The existing treatment standard for methanol in wastes subject to UTS is developed from biological treatment performance data. Therefore, treatment for other constituents identified in this table are also expected to treat methanol to below its UTS.
A. Wastes that do not exceed the 40 CFR 261.32 listing criteria for formaldehyde are not subject to the treatment technology requirements, but are subject to all other numerical standards.

BDAT for Metals Already on UTS

In developing UTS for antimony, EPA identified the appropriate BDAT as lime addition followed by sedimentation followed by filtration (EPA, 1994b).

BDAT for Organic Constituents Already on UTS

EPA previously developed UTS for the following ten organic constituents, identifying the indicated treatment technology as BDAT (EPA, 1994b).

Wet air oxidation was selected as BDAT for acrylamide and xylenes (mixed isomers). This technology was selected for acrylamide because it is the only technology for which wastewater treatment performance data were available and wet air oxidation was demonstrated as having high removal efficiency (to 99.45 percent) of acrylamide across the treatment system. For xylenes (mixed isomers), wet air oxidation was selected as BDAT from the combined data of o- and m-xylene because it represents full-scale data with a high influent concentration range and high removal efficiency.

Biological treatment data were used to develop the UTS of the following six constituents:

- acrylonitrile
- ethyl benzene
- methyl isobutyl ketone
- n-butyl alcohol
- methyl methacrylate.

Data from a full-scale system were used, generated during development of the effluent guidelines for the organic chemicals industry, for acrylonitrile and ethyl benzene. The data demonstrated removal and destruction to greater than 99 percent for acrylonitrile (no removal percentage was provided for ethyl benzene).

For methyl isobutyl ketone, industry commenter data from a bench system was used demonstrating removal and destruction to greater than 97 percent. For n-butyl alcohol, industry commenter data from a system of unspecified scale was used demonstrating removal and destruction to 29 percent. For methyl methacrylate, no wastewater treatment performance data were available and therefore treatment performance data and BDAT were transferred from methyl isobutyl ketone, a constituent assumed to be similar in composition and functional groups.

Steam stripping data were used to develop UTS for methylene chloride and toluene. Data from a full-scale system were used, generated during development of the effluent guidelines for the organic chemicals industry. No percent removal data were reported.

Wet air oxidation or chemical oxidation, followed by carbon adsorption; or incineration, is the technology-specific treatment standard for formaldehyde in U122 wastes. EPA does not have performance data for formaldehyde.

BDAT for Organic Constituents Proposed for Addition to UTS

Derivation of the proposed numerical treatment standard for styrene is presented in Appendix A. For styrene, EPA is proposing a numerical treatment standard derived from full-scale **activated sludge biological treatment** data showing destruction and removal efficiencies of at least 90 percent.

3.2.4 BDAT for Wastewater Forms of K179 and K180: Conclusion

EPA does not anticipate that every waste generated must be treated for every constituent. Some constituents will not be present above the proposed treatment standards and therefore will not require treatment. In the case of formaldehyde, treatment to address this constituent is not required unless its concentration in the waste exceeds the listing criteria. Finally, alternative technologies, other than those selected as BDAT, are sometimes appropriate for treating the waste to below the treatment standard.

EPA identified lime addition followed by sedimentation followed by filtration as BDAT for antimony. If both antimony and organics are present in the waste and require treatment to meet LDRs, EPA expects that facilities can conduct this or a similar treatment technology to remove antimony prior to further treatment for organics.

The BDAT for the majority of organic constituents found in K179 and K180 wastes was found to be biological treatment or activated sludge biological treatment. Steam stripping was identified as BDAT for two constituents, and wet air oxidation was identified as BDAT for two other constituents. For formaldehyde, BDAT was identified as a treatment train consisting of wet air oxidation or chemical oxidation, followed by carbon adsorption; or incineration.

EPA anticipates that a treatment train containing all of these components would be unnecessary. Instead, EPA expects that either one of the following two treatment techniques may be appropriate in most instances: (1) biological treatment or activated sludge biological treatment, or (2) wet air oxidation or chemical oxidation, followed by carbon adsorption.

Effectiveness of Biological Treatment or Activated Sludge Biological Treatment

EPA notes that biological treatment has been identified as BDAT for six of the eleven organic constituents in K179 or K180. For the remaining constituents:

- Treatment for one constituent, formaldehyde, would not be required if it is present at levels below the proposed 'listing concentration.'

- Treatment data for methylene chloride, toluene, and xylenes are available for activated sludge biological treatment (EPA, 1994b). For each constituent, treatment to below the proposed treatment standard has been demonstrated, with removal efficiency of at least 98 percent. These data show that activated sludge biological treatment could appropriately treat these constituents.

- For acrylamide, no treatment data are available for any technology except wet air oxidation. Therefore EPA acknowledges some uncertainty regarding the performance of other treatment technologies for this constituent.

Based on the above analysis, EPA anticipates that biological treatment or activated sludge biological treatment could adequately treat the organic constituents in the waste to below the proposed treatment standards prior to land disposal, so long as treatment of formaldehyde was not required.

Effectiveness of Wet Air Oxidation or Chemical Oxidation,

Followed by Carbon Adsorption

If treatment for formaldehyde was required, then compliance with the proposed technology-specific standard for formaldehyde would be required. EPA anticipates that this technology train could also treat all other organic constituents present in the wastes, because at least one of the treatment steps (chemical or wet air oxidation, and carbon adsorption) is likely to remove the constituent from the waste. Available information on these technologies in treating the subject constituents are summarized as follows (EPA 1994b):

- Two constituents, acrylamide and xylenes, have treatment standards derived from wet air oxidation treatment data.

- Wet air oxidation data are available for methylene chloride, ethyl benzene, and methyl isobutyl ketone showing treatment to below their proposed treatment standards (0.089 mg/L for methylene chloride, 0.057 mg/L for ethyl benzene, and 0.14 mg/L for methyl isobutyl ketone); removal efficiency of at least 99 percent was obtained in each case. For acrylonitrile, treatment to below the proposed treatment standard of 0.24 mg/L has not been demonstrated but available data show very high removal efficiencies of greater than 99 percent.

- For toluene, treatment to below the proposed treatment standard of 0.080 mg/L has been demonstrated with a removal efficiency of 72 percent in one instance. Removal efficiencies of greater than 98 percent have been shown for higher concentrations of toluene (but which resulted in final concentrations above the proposed treatment standard).

- For methyl methacrylate, n-butyl alcohol, and styrene, no wet air oxidation, chemical oxidation, or carbon adsorption data are available. Therefore EPA acknowledges some uncertainty regarding the performance of these treatment technologies for these constituents.

Proposed Treatment Standards

The proposed treatment standards for wastewater forms of K179 and K180 are summarized in Table 3–1. For the one metal and for all but two of the organic constituents found in K179 and K180, the proposed treatment standards are equivalent to promulgated UTS for all constituents with such standards. For styrene, which currently does not have a UTS, EPA is proposing a numerical treatment standard of 0.028 mg/L for wastewater forms of wastes. EPA's calculation of the proposed treatment standards are in Appendix A. For formaldehyde, EPA is proposing that a technology-specific treatment standard be met if the constituent is present at levels above 12,000 mg/kg in K180 waste, which is the limit identified in the concentration-based listing.

If the proposed numerical treatment levels are finalized for wastewater forms of K179 and K180, the use of any technology (other than impermissible dilution) would be allowed in complying with the treatment standards except for formaldehyde in K180. Therefore, facilities are not required to use any particular treatment train described above to manage wastewater forms of K179 and K180, and may find they can use an alternative treatment train to meet the proposed numerical treatment standards. Facilities would be required to meet the proposed treatment standards prior to land disposal.

In the case of formaldehyde, technology based treatment standards are being proposed. The standard would require formaldehyde to be treated by either wet oxidation or CHOXD followed by CARBN; or combustion. When formaldehyde is present in K180 at levels triggering the listing, the waste must be treated by the required technologies and then comply with any applicable numerical standards. Wastes that do not trigger the listing based on formaldehyde are not subject to the formaldehyde technology requirement, but are subject to all other numerical standards.

3.3 Nonwastewater Forms of K179 and K180

3.3.1 Applicable and Demonstrated Technologies for Treating Organic Constituents

The technologies listed in this section are applicable and have been demonstrated to treat organic constituents in nonwastewater forms of other hazardous wastes. They are expected to be applicable to wastes with physical and chemical forms similar to K179 and K180. EPA (1994a) presents a thorough discussion of these technologies. Those technologies deemed applicable to the physical and chemical characteristics of K179 and K180 are as follows:

- Incineration
- Fuel substitution
- Solvent extraction
- Critical fluid extraction
- Pressure filtration
- Thermal drying of biological treatment sludge
- Thermal desorption
- Total recycle or reuse

Except for total waste recycle and reuse, all of the treatment methods listed above generate additional wastes in liquid or solid form. Such wastes would require additional management, including additional treatment to meet applicable land disposal restriction treatment standards if necessary. Each technology is described below.

Incineration

Incineration is a destruction technology in which heat is transferred to the waste to destabilize chemical bonds and destroy hazardous organic constituents. Off-gases (following additional combustion in an afterburner) are fed to a scrubber system for cooling and for removal of entrained particles and acid gas. Three incineration technologies are applicable and demonstrated for organics in nonwastewaters: liquid injection, rotary kiln, and fluidized-bed. Incineration potentially may produce two residuals: scrubber water and ash. Waste properties, the type of incineration system used, and the air pollution control devices employed dictate the quantity of each residual generated.

Fuel Substitution

Fuel substitution is a treatment technology in which heat is transferred to a waste to destabilize chemical bonds and destroy organic constituents. The process uses hazardous waste as fuel in industrial furnaces or boilers. The hazardous waste may be blended with other nonhazardous wastes and/or fossil fuels. It has been used in the treatment of industrial waste solvents, refinery wastes, synthetic fibers/petrochemical wastes, waste oils, and wastes produced during the manufacture of pharmaceuticals, pulp and paper, and pesticides. Fuel substitution generates two residuals: ash and scrubber water.

Solvent Extraction

Solvent extraction is a separation and recovery technology. The process removes organic constituents from a waste by mixing the waste with a solvent that preferentially dissolves and removes the hazardous constituents from the waste. Wastes treated by this technology have a wide range of total organic content; selection of an appropriate solvent depends on the relative solubilities of the constituents to be removed and the other organic compounds in the waste. This technology generates two residuals: a treated waste residual and an extract.

Critical Fluid Extraction

This is a separation and recovery technology in which a solvent is brought to its critical state (liquified gas) to extract organic constituents from a waste. The solvents used are usually gases at ambient conditions. The solvent is converted from a gas to a liquid via pressurization. As a liquid, the solvent dissolved the organic constituents and extracts them from the waste matrix. Once it is extracted the solvent is returned to its original gaseous state. The technology generates two residuals: a treated waste residual and an extract. The extract is usually recycled or treated by incineration.

Pressure Filtration

Pressure filtration, also known as sludge dewatering, is a separation and recovery technology used for wastes that contain high concentrations (greater than 1 percent) of suspended solids. It separates particles from a fluid/particle mixture by passing the fluid through a medium that permits the flow of the fluid but retains particles. Pressure filtration generates two residuals: dewatered sludge and water. For organics that are partitioned to suspended solids, this technology concentrates the organics in the solid residual, making the organic constituents more amenable for treatment using other technologies described in this section.

Thermal Drying

Thermal drying of biological treatment sludge is a destruction technology which uses controlled flame combustion or indirect heat transfer to elevate the temperature of the waste and, thereby volatilizes the organic constituents. Off-gas from the dryer is sent to an afterburner to complete combustion of the volatile component. This process generates two residuals: a treated waste residual and an extract.

Thermal Desorption

This is a separation and recovery technology in which direct or indirect heat exchange is used to volatilize organic constituents from wastes. Different from incineration, thermal desorption works by elevating the temperature of the organic constituents to effect a phase separation to a gaseous state without combustion. Thermal desorption units function by creating steam from the volatilization of the moisture in the waste from heating. The technology generates two residuals: a treated waste residual and an extract.

Total Recycle or Reuse

Total recycle or reuse within the same process or an external process eliminates waste generation. As a result of recycling, however, impurities may require removal from the system on a periodic or continuous basis.

3.3.2 Applicable and Demonstrated Technologies for Treating Metals

Applicable treatment technologies for metals include those that immobilize or reduce the total amount of metal constituents in a waste. The technologies listed in this section are applicable and have been demonstrated to treat metal constituents in nonwastewater forms of other hazardous wastes. These technologies are commonly used to treat wastes which contain the metal constituents regulated by universal treatment standards. EPA (1988a; 1990a; 1994a) presents a thorough discussion of these technologies. The technologies applicable to wastes with the physical and chemical characteristics of K179 and K180 include:

- Acid Leaching
- Vitrification
- Stabilization
- Pyrometallurgical recovery process (high temperature metals recovery, or HTMR)
- Hydrometallurgical recovery processes
- Recycling.

Acid Leaching

Acid leaching is a process that removes soluble constituents from an insoluble matrix by contact with a strongly acidic solution. The soluble contaminant is more soluble in an acidic solution and will be transferred to the acid phase. The solids are separated from the liquid (e.g., using filtration or equipment design). This treatment process generates two residuals: a treated solid and an acidic, metal-laden liquid which requires additional treatment or recovery.

Vitrification

Glass vitrification and slag vitrification are high temperature stabilization technologies that are applicable for treatment of arsenic-containing wastes. In either type of vitrification process, the waste is blended with lime, soda ash, silica, and other glass making ingredients (such that the ending volume is greater than the initial waste volume). Material is fed to a furnace containing molten glass, so that organics in the waste are vaporized (or destroyed) and metals are dissolved. Volatile metals (such as arsenic compounds) condense within the furnace. The glass is removed and cooled. The process generates a single solid waste treatment residual.

Stabilization

Stabilization is a broad class of treatment technologies that reduces the mobility of metal constituents in a waste; the metals are chemically bound into a solid matrix that resists leaching when water or a mild acid solution comes into contact with the waste material. Organic materials usually are not stabilized effectively and may, in fact, inhibit the stabilization of metals. Hence, stabilization is applicable to nonwastewaters only after the organics have been removed by other treatment.

Pyrometallurgical Recovery Processes (High Temperature Metals Recovery)

Pyrometallurgical recovery processes are those treatment technologies that use physical and chemical reactions at elevated temperatures for extraction/separation of metals, ores, salts, and other materials. For the purposes of the Land Disposal Restrictions Program, pyrometallurgical processes are referred to as High Temperature Metals Recovery (HTMR). Some examples of HTMR systems include rotary kilns, flame reactors, electric furnaces, plasma arc furnaces, slag reactors, and rotary hearth/electric furnaces. These thermal reduction processes use carbon, limestone, and silica (sand) as raw materials. The carbon acts as a reducing agent and reacts with metal oxides in a high temperature processing unit (e.g., kiln, furnace) to produce carbon dioxide and a free metal. This process yields a metal product for reuse and reduces the concentration of metals in the residuals.

Hydrometallurgical Recovery Processes

Hydrometallurgical recovery processes extract and recover materials by using acidic solutions. These processes are most effective with wastes containing high concentrations of metals that are soluble in a strong acid solution or that can be converted by reaction with a strong acid to a soluble form.

Some hydrometallurgical processes include chemical precipitation, leaching, ion exchange, solvent extraction, and electrowinning.

Recycling

For some metal-bearing wastes, recycling may be an applicable technology. Such practices facilitate the recovery of metals while reducing or eliminating the material designated for land disposal.

3.3.3 Identification of BDAT and Proposed Treatment Standards for Nonwastewater Forms of K179 and K180

BDAT for Metals

EPA proposes to apply previously promulgated UTS to antimony in K179 and K180. UTS were calculated for antimony based on BDAT of stabilization (63 FR 28562, May 26, 1998). Based on data used in treatment standards development for the 1998 rule, EPA expects both high temperature metals recovery (HTMR) or stabilization to be capable of meeting the standard.

BDAT for Organic Constituents

Incineration is identified as BDAT in the *Final Best Demonstrated Available Technology (BDAT) Background Document for Universal Treatment Standards Volume A: Universal Treatment Standards for Nonwastewater Forms of Listed Hazardous Wastes* (U.S. EPA, July 1994) for the following nine organic constituents:[2]

- acrylamide
- acrylonitrile

[2] This background document also identified that incineration is BDAT for methanol. Therefore methanol is expected to be treated in a similar manner as the other constituents described in this section for which EPA is proposing treatment standards. EPA is soliciting comment on including methanol as a basis for listing K180; treatment standards would be similarly added.

- n-butyl alcohol
- methylene chloride
- ethylbenzene
- methyl isobutyl ketone
- methyl methacrylate
- toluene
- xylene (mixed isomers).

In developing UTS for organic constituents, EPA identified combustion treatment as BDAT for formaldehyde in K180. EPA is proposing a nonwastewater treatment standard for styrene based on thermal destruction.

3.3.4 BDAT for Nonwastewater Forms of K179 and K180: Conclusion

Treatment standards for nonwastewater forms of K179 and K180 are summarized in Table 3–1. EPA identified stabilization as BDAT for antimony. Organic constituents found in K179 and K180 wastes are best treated by incineration, combustion, or similar processes. To adequately treat both metals and organics potentially present in nonwastewater forms of K179 and K180, EPA identifies a treatment train consisting of combustion (for organics treatment) followed by stabilization (for metals treatment) as BDAT.

For the one metal and for nine of the eleven organic constituents found K179 and K180, the proposed treatment standards are equivalent to promulgated UTS. For nonwastewater forms of wastes containing styrene, EPA is proposing a numerical standard of 28 mg/kg developed for this rulemaking. EPA's calculation of the proposed treatment standard is in Appendix A. For nonwastewater forms of wastes containing formaldehyde above the listing criteria, a technology specific treatment standard is being proposed. The standard would require formaldehyde to be treated by combustion. When formaldehyde is present in K180 at levels triggering the listing, the waste must be treated by the required technology and then comply with any applicable numerical standards for other constituents. Wastes that do not trigger the listing based on formaldehyde are not subject to the formaldehyde technology requirement, but are subject to all other numerical standards.

If the proposed numerical treatment levels are finalized for nonwastewater forms of K179 and K180, the use of any technology (other than impermissible dilution) would be allowed in complying with the treatment standards. Therefore, facilities are not required to use the above treatment train to manage wastewater forms of K179 and K180, and may find they can use an alternative treatment train to meet the proposed numerical treatment standards.

4.0 REFERENCES

EPA. 1994a. Final Best Demonstrated Available Technology (BDAT) Background Document for Universal Standards, Volume A: Universal Standards for Nonwastewater Forms of Listed Hazardous Wastes. Office of Solid Waste.

EPA. 1994b. Final Best Demonstrated Available Technology (BDAT) Background Document for Universal Standards: Volume B: Universal Standards for Wastewater Forms of Listed Hazardous Wastes. Office of Solid Waste.

EPA. 1991. Final Best Demonstrated Available Technology (BDAT) Background Document for Quality Assurance/Quality Control Procedures and Methodology, October 1991.

APPENDIX A. NUMERICAL TREATMENT STANDARD DEVELOPMENT FOR CONSTITUENTS IN PAINT PRODUCTION WASTES

EPA has previously promulgated numerical treatment standards (i.e., universal treatment standards, or UTS) for all but two constituents proposed for inclusion in 40 CFR 268.40 for wastewater or nonwastewater forms of K179 to K180. Numerical treatment standards in K179 and K180 wastes are being proposed for styrene. Technology based treatment standards are being proposed for formaldehyde. Available data and information for these two constituents are presented in this appendix.

For each constituent, a brief summary of the available treatment data from EPA's National Risk Management Research Laboratory (NRMRL) Treatability Database, Version 5.0, 1994 is provided. Where applicable, any outstanding analytical issues and possible technology transfer opportunities from similar constituents already regulated are identified. The calculation showing treatment standard development for styrene is presented in this appendix as well.

A.1 Treatment Data for Formaldehyde

The NRMRL Database does not contain any treatment data for formaldehyde for either wastewaters or nonwastewaters. Note that formaldehyde is a gas in its natural state but is typically sold as a 37% solution, commonly known as formalin. Formalin typically contains up to 15% methanol, added to inhibit polymerization.

Currently, the UTS do not contain any simple aldehydes, although three simple ketones and one unsaturated carbonyl (aldehydes and ketones are in the carbonyl family) are regulated, including acetone, methyl ethyl ketone (MEK), methyl isobutyl ketone (MIBK), and acrolein:

Formaldehyde [CHCO]	**MW = 30, BP = –19ºC, vapor density = 1.08**
Acetone [CH_3COCH_3]	MW = 54, BP = 56ºC, s.g. = 0.792
MEK [$CH_3COCH_2CH_3$]	MW = 68, BP = 79.6ºC, s.g. = 0.8255

MIBK [$CH_3COCH_2CH(CH_3)_2$] MW = 100, BP 116ºC, s.g. = 0.8042
Acrolein [CH_2CHCHO] MW = 56, BP = 52, s.g. = 0.8427

UTS for Acetone: wastewater = 0.28 mg/L nonwastewater = 160 mg/kg
UTS for MEK: wastewater = 0.28 mg/L nonwastewater = 36 mg/kg
UTS for MIBK: wastewater = 0.14 mg/L nonwastewater = 33 mg/kg
UTS for Acrolein: wastewater = 0.29 mg/L nonwastewater = NA

Validated analytical methods for formaldehyde do exist for both wastewaters and nonwastewaters with a sensitivity of 20 to 50 ppb, as shown in Table A–1.

Due to the absence of treatment performance data, EPA is not proposing a numerical treatment standard for formaldehyde.

Table A–1 Analytical Procedures For Styrene and Formaldehyde

Analyte	CAS #	Water Prep.	Soil Prep.	Determ. Method	Sensitivity
Styrene	100-42-5	5030B/5032	5035/5032	8260B/8021B	1 to 10 ppb
Formaldehyde	50-00-0	8315A	8315A	8315A	20 to 50 ppb

- DAI = Direct aqueous injection (this procedure in described in Method 8015B and other SW-846 methods).
- Sensitivity is expressed here for Method 8260 is an estimate of the level at which quantitative measurements could be made. For aqueous samples, the lower limit of the sensitivity may require using a 25-mL purge volume for those analyte amenable to purge-and-trap techniques (5030/5035). The upper limit is an estimate of the sensitivity that can be achieved by purging a 5-g solid sample. Styrene could be analyzed by Method 8021B with better sensitivity than 8260B, even using a 5-mL purge volume for water.
- Method 8315A contains both the sample preparation and determinative portions of the method. The sensitivity for formaldehyde is estimated as about 3 times the MDL data provided in Method 8315A.

A.2 Treatment Data for Styrene

The NRMRL Database contains data from four references for six different treatment technologies for wastewaters and from 11 references for 10 different treatment technologies for nonwastewaters. For wastewaters, average effluent concentrations ranged from 1.9 ug/L to a maximum concentration of 250 ug/L. Activated sludge, air stripping, sedimentation, and sedimentation followed by activated sludge were the four most successful treatment technologies, all with average effluent concentrations less than 16 ug/L (<0.016 mg/L) and average removal efficiencies of greater than 50%. For nonwastewaters, average effluent concentrations ranged from <3 ug/kg to 790 mg/kg for total constituent analyses and from 10 ug/L to 38 mg/L for TCLP analyses. Numerous treatment technologies demonstrated greater than 95% removal for both total constituent analyses and TCLP analyses.

Currently, the UTS contain four arenes, including benzene, ethylbenzene, toluene, and mixed xylenes:

Styrene [$C_6H_5CHCH_2$]	**MW = 104, BP = 145ºC, s.g. = 0.9045**
Benzene [C_6H_6]	MW = 78, BP = 80ºC, s.g. = 0.8790
Ethylbenzene [$C_6H_5C_2H_5$]	MW = 106, BP = 136ºC, s.g. = 0.867
Toluene [$C_6H_5CH_3$]	MW = 92, BP = 111ºC, s.g. = 0.86–0.88
Xylenes [$C_6H_4(CH_3)_2$]	MW = 106, BP = 138–144ºC, s.g. = 0.86

UTS for Benzene:	wastewater = 0.14 mg/L	nonwastewater = 10 mg/kg
UTS for Ethylbenzene:	wastewater = 0.057 mg/L	nonwastewater = 10 mg/kg
UTS for Toluene:	wastewater = 0.0095 mg/L	nonwastewater = 10 mg/kg
UTS for Xylenes:	wastewater = 0.32 mg/L	nonwastewater = 30 mg/kg

Validated analytical methods for styrene do exist for both wastewaters and nonwastewaters with a sensitivity of 1 to 10 ppb, as shown in Table A–1.

A.3 Treatment Standard Calculation for Styrene

A.3.1 Wastewaters

Available Data

EPA's available treatment data for wastewater forms of styrene, identified in Table A–2, include the following technologies:

- Full scale activated sludge treatment of domestic wastewater, Superfund wastewater, and chemical industry wastewater.
- Full scale air stripping of domestic wastewater and Superfund wastewater.

- Full scale chemical precipitation of Superfund wastewaster.
- Full scale filtration of Superfund wastewaster.
- Full scale sedimentation of domestic wastewater.
- Full scale sedimentation followed by activated sludge treatment of chemical industry wastewater.

EPA has previously selected treatment data based on biological treatment as BDAT for a wide variety of organic constituents. Biological treatment has been shown to be able to treat many of the organic constituents potentially present in K179 and K180 to below the existing UTS. Due to its effectiveness in treating organic constituents in general, and due to the existence of data from a full-scale system for styrene, EPA is selecting treatment data from activated sludge treatment as BDAT for styrene.

Data Used for Calculation

Based on the data in Table A–2, EPA selected a single data point from activated sludge treatment in developing the proposed treatment standard. The specific data identified resulted in a final concentration of less than 0.010 mg/L, with initial concentrations in the range of 0.1 to 1 mg/L to. EPA selected this particular data point for the following reasons:

- The matrix is industrial wastewater from the chemical industry. This matrix is expected to be most similar to wastewater forms of K179 and K180. For this reason, the chemical industry wastewater data were used preferentially over the domestic and Superfund wastewater data.

- EPA selected the data point with the highest initial concentration of styrene. This is expected to be representative of the most 'difficult to treat' waste.

Calculation of Proposed Treatment Standard

EPA uses the following calculation method for treatment standards:[3]

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[3] EPA, Final Best Demonstrated Available Technology (BDAT) Background Document for Quality Assurance/Quality Control Procedures and Methodology, October 1991.

	Average treatment value in acceptable analytical data
x	Accuracy correction factor
x	Variability factor
=	Calculated treatment standard.

In this case, the average treatment value used was 0.010 mg/L (in cases where the final value is below detection, EPA uses the detection limit in calculations). The accuracy correction factor was 1.0, and the variability factor was 2.8 (the selection of these values are detailed below). This resulted in a calculated treatment standard of 28 mg/kg.

Accuracy Correction Factor

The accuracy correction factor adjusts the average treatment value based on evaluation of laboratory quality control results, specifically the matrix spike recovery result. In this case, EPA's treatability database did not identify if such data were available, and EPA did not investigate if the source report contained such information. In general, EPA does not expect styrene to present significant analytical difficulties. Due to the lack of quality control data for the treatment data identified, and because EPA anticipates that any such correction would not be significant, EPA is using an accuracy correction factor of 1.0.

Variability Factor

The variability factor takes into account the inherent fluctuation in any waste treatment system resulting from sampling and analysis, mechanical limitations, and changes in the influent. Statistically, the variability factor is equal to the 99^{th} percentile concentration divided by the mean (i.e., the 99^{th} percentile concentration is the estimated concentration for which 99 percent of the daily observations will be below, and in turn is calculated from the mean and standard deviation of the sample set). In this case, only a single, average data point is available. EPA assigned a variability factor of 2.8 in this case because this is the factor normally applied when using non-detect data, using its methodology described in its 1991 Quality Assurance Background Document.

A.3.2 Nonwastewaters

Available Data

In calculating a treatment standard, EPA generally bases its calculations on the performance of best demonstrated available technology (BDAT). EPA's available treatment data for nonwastewater forms of styrene, identified in Table A–3, include the following technologies:

- Biological destruction
- Chemical destruction
- Soil washing
- Low temperature desorption of soil
- Solidification of soil
- Solvent extraction of soil
- Thermal destruction of sludge
- Thermal destruction of soil

EPA has previously selected combustion technologies as BDAT for virtually all organics in developing UTS. Combustion technologies have been demonstrated to destroy a wide variety of organic constituents to non-detect levels in a variety of matrices. The data of Table A–3 show that thermal destruction of soil and sludge can be reduced to non-detect levels of styrene. Therefore, even though the available data are from pilot scale operations, EPA is using these data for developing the proposed treatment standard. Commercially available full-scale thermal destruction processes (such as combustion and incineration) are expected to provide similar performance.

Data Used for Calculation

Based on the data in Table A–3, EPA selected data from the thermal destruction of sludge in developing the proposed treatment standard. The specific data identified reduces total levels from 73 mg/kg to less than 10 mg/kg. EPA selected this particular data point for the following reasons:

- It results in non-detect levels of styrene, which is to be expected from combustion processes.

- The characteristics of nonwastewater forms of K179 and K180, as well as nonwastewater forms of characteristic wastes which would be subject to UTS, are expected to have greater resemblance to sludges than to soil. For this reason, the sludge data were used preferentially over the soils data.

- EPA selected the data point with the highest initial concentration of styrene. This is expected to be representative of the most 'difficult to treat' waste.

Calculation of Proposed Treatment Standard

EPA uses the following calculation method for treatment standards:[4]

	Average treatment value in acceptable analytical data
x	Accuracy correction factor
x	Variability factor
=	Calculated treatment standard.

In this case, the average treatment value used was 10 mg/kg (in cases where the final value is below detection, EPA uses the detection limit in calculations). The accuracy correction factor was 1.0, and the variability factor was 2.8 (the selection of these values are detailed below). This resulted in a calculated treatment standard of 28 mg/kg.

Accuracy Correction Factor

The accuracy correction factor adjusts the average treatment value based on evaluation of laboratory quality control results, specifically the matrix spike recovery result. In this case, EPA's treatability database did not identify if such data were available, and EPA did not investigate if the source report contained such information. In general, EPA does not expect styrene to present

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[4] EPA, Final Best Demonstrated Available Technology (BDAT) Background Document for Quality Assurance/Quality Control Procedures and Methodology, October 1991.

significant analytical difficulties. Due to the lack of quality control data for the treatment data identified, and because EPA anticipates that any such correction would not be significant, EPA is using an accuracy correction factor of 1.0.

Variability Factor

The variability factor takes into account the inherent fluctuation in any waste treatment system resulting from sampling and analysis, mechanical limitations, and changes in the influent. Statistically, the variability factor is equal to the 99^{th} percentile concentration divided by the mean (i.e., the 99^{th} percentile concentration is the estimated concentration for which 99 percent of the daily observations will be below, and in turn is calculated from the mean and standard deviation of the sample set). In this case, only a single, average data point is available. EPA assigned a variability factor of 2.8 in this case because this is the factor normally applied when using non-detect data, using its methodology described in its 1991 Quality Assurance Background Document.

Table A–2 Treatment Data Available for Styrene in Wastewater Matrices

Technology	Scale	Range of Influent Concentrations (µg/L)	No. of Data Points	Average Effluent Concentration (µg/L)	Percent Removal	Notes	Reference
Activated Sludge	Full	0-100	10	1.9	96.4	Domestic wastewater	1
			1	<10	>74	Superfund wastewater	4
		100-1,000	2	<10	>90.9	Industrial wastewater (SIC 28)	2
Air Stripping	Full	0-100	9	0.037	51	Domestic wastewater	3
		100-1,000	5	<16	>93.6	Superfund Wastewater	4
Chemical Precipitation	Full	100-1,000	5	240	3	Superfund Wastewater	4
Filtration	Full	0-100	1	11	8	Superfund Wastewater	4
		100-1,000	5	250	0		
Sedimentation	Full	0-100	10	1.9	91.4	Domestic wastewater	1
Sedimentation followed by Activated Sludge	Full	0-100	2	<10	>79	Industrial wastewater (SIC 28)	2

References are identified later in appendix.

Source: U.S. Environmental Protection Agency. National Risk Management Research Laboratory (NRMRL) Treatability Database. Version 5.0. 1994. Database source did not present greater detail of influent range, individual effluent data points, or additional technology or matrix information. Primary references were not investigated for this information.

Table A–3 Treatment Data Available for Styrene in Nonwastewater Matrices

Technology and Matrix	Scale	Initial Concentration	No. of Data Points	Final Concentration	Percent Removal	Notes	Reference
Biological Destruction, Aerobic, Slurry of Sludge	Pilot	1.3 mg/gm total	1	<1.0 ug / gm total	>99.923	90 days aeration	5
Biological Destruction, Aerobic, Slurry of Soil	Bench	56 mg/kg total	2	<1.8 mg/kg total	>96.8	8 wks, 200 gm/L	6
		67 mg/kg total	2	<2.8 mg/kg total	>95.8		
Biological Destruction, Aerobic, Solid Phase of Soil	Bench	190 ug/kg total	1	<25 ug/kg total	>87	Nutrients & organic	7
			1	<25 ug/kg total	>87	Nutrients & microorganisms	
			1	<25 ug/kg total	>87	Nutrients	
	Pilot	10 mg/kg total	4	<35 ug/kg total	>99.65	Control	
		100 mg/kg total	4	3 ug/kg total	99.997	Organisms added	
		51 mg/kg total	3	<5 ug/kg total	>99.990		
		6.5 mg/kg total	4	<11 ug/kg total	>99.83	Nutrients added	
Chemical Destruction of Soil	Bench	120 mg/kg total	1	490 ug/kg total	99.59	KPEG,100 C,2 hr	8
			1	57 ug/kg total	99.952		
		40 mg/kg total	1	770 ug/kg total	98.1		
			1	55 ug/kg total	99.86		
		720 mg/kg total	1	35 ug/kg total	99.9951		
			1	13 mg/kg total	98.2		
		830 mg/kg total	1	370 ug/kg total	99.955		
			1	27 mg/kg total	96.7		
Classification/ Washing of Soil	Bench	11 mg/L TCLP	1	30 ug/L TCLP	99.73	0.5% Tide, 30 min	9
			1	140 ug/L TCLP	98.7	5.4% EDTA, 15 min	
			1	70 ug/L TCLP	99.36	H20, 15 min.	
		30 ug/L TCLP	1	20 ug/L TCLP	33	5.4% EDTA, 15 min	
			1	50 ug/L TCLP	0	0.5% Tide, 30 min	
			1	2.3 mg/L TCLP	0	H20, 15 min.	
		32 mg/kg total	1	<5 ug/kg total	>99.984	5.4% EDTA, 15 min	
			1	26 ug/kg total	99.919	H2o, 15 min.	
		42 mg/kg total	1	16 ug/kg total	99.962	H2O, 15 min.	
			1	10 ug/kg total	99.976	0.5% Tide, 30 min	
			1	<6 ug/kg total	>99.986	5.4% EDTA, 15 min	
		500 ug/L TCLP	1	80 ug/L TCLP	84	5.4% EDTA, 15 min	
			1	50 ug/L TCLP	90	H20, 15 min.	
		630 mg/kg total	1	<25 ug/kg total	>99.9960	H2O, 15 min.	
			1	170 ug/kg total	99.973	5.4% Tide, 30 min	
			1	<26 ug/kg total	>99.9959	5.4% EDTA, 15 min	

Table A–3 Treatment Data Available for Styrene in Nonwastewater Matrices

Technology and Matrix	Scale	Initial Concentration	No. of Data Points	Final Concentration	Percent Removal	Notes	Reference
		710 mg/kg total	1	<170 ug/kg total	>99.976	0.5% Tide, 30 min	
Classification/ Washing of Soil	Bench	710 mg/kg total	1	<26 ug/kg total	>99.9963	H2O, 15 min.	9
		9 mg/L TCLP	1	120 ug/L TCLP	98.7	H20, 15 min.	
		9 mg/L TCLP	1	130 ug/L TCLP	98.6	0.5% Tide, 30 min	
Low Temperature Desorption of Soil	Bench	11 mg/L TCLP	2	<100 ug/L TCLP	>99.09	342 F for 30 min	10
			3	<100 ug/L TCLP	>99.09	550 F for 30 min	
			1	<3.1 mg/L TCLP	>72	161 F for 30 min	
		300 ug/L TCLP	3	<100 ug/L TCLP	>67	551 F for 30 min	
			2	<100 ug/L TCLP	>67	150 F for 30 min	
			1	<100 ug/L TCLP	>67	350 F for 30 min	
		650 mg/kg total	3	<6 ug/kg total	>99.9991	564 F for 30 min	
			2	<15 ug/kg total	>99.9977	342 F for 30 min	
			1	<0.25 mg/kg total	>99.962	158 F for 30 min	
			1	<5 mg/kg total	>99.23	161 F for 30 min	
			1	<5 mg/kg total	>99.9992	364 F for 30 min	
			3	<5 ug/kg total	>99.9992	550 F for 30 min	
Solidification of Soil	Bench	11 mg/L TCLP	1	3.6 mg/L TCLP	67	Lime/flyash, 28 Day	11
			1	4.1 mg/L TCLP	63	Kiln Dust,28 Day	
			1	38 mg/L TCLP	0	Cement, 28 Day	
		24 mg/kg total	1	790 ug/kg total	96.7	Kiln Dust,28 Day	
			1	8.7 mg/kg total	64	Cement, 28 Day	
			1	1.2 mg/kg total	95	Lime/flyash, 28 Day	
		26 mg/kg total	1	140 ug/kg total	99.46	Lime/flyash, 28 Day	
			1	20 ug/kg total	99.923	Kiln Dust,28 Day	
			1	1.8 mg/kg total	93.1	Cement, 28 Day	
		30 ug/L TCLP	1	100 ug/L TCLP	0	Kiln Dust,28 Day	
			1	30 ug/L TCLP	0	Lime/flyash, 28 Day	
			1	30 ug/L TCLP	0	Cement, 28 Day	
		500 ug/L TCLP	1	60 ug/L TCLP	88	Lime/flyash, 28 Day	
			1	10 ug/L TCLP	98	Kiln Dust,28 Day	
			1	20 ug/L TCLP	96	Cement, 28 Day	
		540 mg/kg total	1	130 mg/kg total	76	Lime/flyash, 28 Day	
			1	350 mg/kg total	35	Cement, 28 Day	
			1	45 mg/kg total	91.7	Kiln Dust,28 Day	
		710 mg/kg total	1	150 mg/kg total	79	Lime/flyash, 28 Day	
			1	220 mg/kg total	69	Cement, 28 Day	
			1	5.6 mg/kg total	99.21	Kiln Dust,28 Day	
		9 mg/L TCLP	1	4.1 mg/L TCLP	54	Lime/flyash, 28 Day	
			1	1.1 mg/L TCLP	88	Kiln Dust,28 Day	
			1	2.8 mg/L TCLP	69	Cement, 28 Day	

Table A–3 Treatment Data Available for Styrene in Nonwastewater Matrices

Technology and Matrix	Scale	Initial Concentration	No. of Data Points	Final Concentration	Percent Removal	Notes	Reference
Solvent Extraction of Soil	Bench	100 mg/kg total	1	<2.4 mg/kg total	>97.6	TEA,6 stg.	6
		87 mg/kg total	1	22 ug/kg total	99.975	Propane,6 stg.	
Thermal Destruction of Sludge	Pilot	16 mg/kg total	3	<3 ug/kg total	>99.981	SCC = 1976 F	12
		30 mg/kg total	3	<2 mg/kg total	>93.3	SCC = 1880 F	13
		73 mg/kg total	3	<10 mg/kg total	>86	TEMP = 2016 F	
Thermal Destruction of Soil	Pilot	10 mg/kg total	1	<5 ug/kg total	>99.950	12 min @ 1572 F	14
		10 mg/kg total	1	<5 ug/kg total	>99.950	18 min @ 1576 F	
		140 mg/kg total	1	<5 ug/kg total	>99.9964	12 min @ 1604 F	
		140 mg/kg total	1	<5 ug/kg total	>99.9964	18 min @ 1604 F	
		2.1 mg/l TCLP	1	110 ug/l TCLP	94.8	1795 F	15
		45 mg/kg DRE	3	1.5 ng/L DRE	99.981	1771 F	
		45 mg/kg total	3	<3 ug/kg total	>99.9933		
		4.7 mg/kg total	1	<5 ug/kg total	>99.89	12 min @ 1554 F	14
		4.7 mg/kg total	1	<5 ug/kg total	>99.89	18 min @ 1588 F	
		580 ug/l TCLP	1	<100 ug/l TCLP	>83	1749 F	15
		720 mg/kg DRE	3	8.5 ng/L DRE	99.9932	1777 F	
		720 mg/kg total	3	<3 ug/kg total	>99.9996		

References are identified later in appendix.

Source: U.S. Environmental Protection Agency. National Risk Management Research Laboratory (NRMRL) Treatability Database. Version 5.0. 1994. Database source did not present greater detail of influent range, individual effluent data points, or additional technology or matrix information. Primary references were not investigated for this information.

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APPENDIX B. TREATMENT PERFORMANCE DATA FOR CONSTITUENTS IN NONWASTEWATER AND WASTEWATER FORMS OF WASTES

Table B–1 Constituents in K179 and K180 Nonwastewaters

Hazardous Constituent Proposed for Regulation	Treatment Technology (BDAT Technology Basis)[a]	Treated Waste Concentration, mg/kg (unless noted)[a]	Proposed Treatment Standard, mg/kg (unless noted)
Acrylamide	Incineration	<6.5	23
Acrylonitrile	Incineration	<30	84
n-Butyl alcohol	Incineration	<0.4	2.6
Methyl isobutyl ketone	Incineration	<10	33
Methyl methacrylate	Incineration	<50	160
Ethyl benzene	Incineration	<2	10
Methanol[b]	Incineration	—	0.75 mg/L TCLP
Methylene chloride	Incineration	<10	33
Toluene	Incineration	<2	10
Xylenes — mixed isomers	Incineration	<10	30
Antimony[c]	Stabilization	0.21 mg/L TCLP	1.15 mg/L TCLP

[a] Data Source unless otherwise noted: U.S. EPA. July 1994. Best Demonstrated Available Technology (BDAT) Background Document for Universal Standards Volume A: Universal Standards for Nonwastewater Forms of Listed Hazardous Wastes.
Data for styrene and formaldehyde are detailed in Appendix A.
[b] Data source: U.S. EPA. Best Demonstrated Available Technology (BDAT) Background Document for F001–F005 Spent Solvents. Final (November 1986). EPA did not present data for methanol. Instead, treatment performance data were transferred from methyl ethyl ketone. Treated waste concentration was <300 mg/kg total, and 0.14 mg/L TCLP.
[c] Data source: 63 FR 28562 (May 26, 1998); Final Rule Land Disposal Regulations Phase IV. Supporting data are indentified in Memorandum, "Calculation of Universal Treatment Standard (UTS) for Antimony Using Data Submitted by Chemical Waste Management and Data Obtained by Rollins." November 10, 1997. www.epa.gov/epaoswer/hazwaste/ldr/ldrmetal/memos/memo10.pdf.

Table B–2 Constituents in K179 and K180 Wastewaters

Hazardous Constituent Proposed for Regulation	Treatment Technology Used[c]	Removal Efficiency, % [a,c]	Average Effluent Concentration, mg/L[c]	Proposed Treatment Standard, mg/L
Acrylamide	Wet Air Oxidation	99.46	4.55	19
Acrylonitrile	Biological Treatment	NR	0.05	0.24
n-Butyl alcohol	Biological Treatment	28.57	2	5.6
Methyl isobutyl ketone	Biological Treatment	97.69	0.05	0.14
Methyl methacrylate	Biological Treatment	—[b]	—[b]	—[b]
Ethyl benzene	Biological Treatment	98.4	0.01	0.057
Methanol	Biological Treatment	87.23	2	5.6
Methylene chloride	Steam Stripping	NR	0.023	0.089
Toluene	Steam Stripping	NR	0.01	0.08
Xylene — mixed isomers	Wet Air Oxidation	99.8	0.056	0.32
Antimony	Lime, Sedimentation, Filtration	NR	0.47	1.9

[a] The percent decrease between the influent and effluent concentration.

[b] No wastewater treatment performance data were available for methyl methacrylate from any of the examined sources. Treatment performance data were therefore transferred to this constituent from methyl isobutyl ketone, a constituent judged to be similar with respect to elemental composition and functional groups. Data for methyl isobutyl ketone were used in developing UTS for methyl methacrylate.

[c] Data Source: U.S. EPA. July 1994. Best Demonstrated Available Technology (BDAT) Background Document for Universal Standards Volume B: Universal Standards for Wastewater Forms of Listed Hazardous Wastes.